Monitoring for Year One Aerial Treatment and Recommendations for Year Two Control of *Phragmites australis* on Colonial National Historic Parkway, Virginia, USA

Interim Report

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Introduction

Phragmites australis Trin. is considered an invasive plant species that will replace wetland vegetation in disturbed marsh habitat in Virginia (Virginia Heritage Program 1992), particularly those caused by human disturbances (e.g. road construction, boat and human access to waterways, power- and pipeline construction and maintenance) and natural disasters (e.g. shoreline erosion, hurricanes, and northeasters). Although a native species, once *P. australis* has a foothold in a marsh it has the capability of rapidly invading and out competing the usual dominant wetland species found in Colonial National Historical Park (COLO) marshes, such as *Spartina alterniflora* (smooth cordgrass), *S. cynosuroidies* (tall cordgrass), and *S. patens* (salt meadow hay). The replacement of the *Spartinas* by *P. australis* leads to loss of both habitat and species diversity (Silberhorn 1999). To that end, resource managers have begun to examine "eradication" methods to minimize the invasion of *P. australis.*

COLO has identified 26 wetland sites in the park that have been invaded by nearly monotypic stands of *P. australis*. Virginia Institute of Marine Science (VIMS) wetland personnel visited each of these sites and, working with COLO Natural Resource Manager, prepared a site-specific management plan, along with a monitoring protocol that could be implemented by park staff (Perry and Stanhope 2002). In the fall of 2003 the National Park Services contracted with Timberland Corporation for the aerial treatment to apply Rodeo (gylphosphate mixture approved for aquatic areas) with a surfactant by helicopter to all of the *Phragmites australis* stands. The Plan included a monitoring protocol method for measuring the success of the treatment and a threshold to determine the need for additional control. This report includes first year monitoring results along with recommendations for year two treatment.

Monitoring Methods

Each site was walked and searched for new (or returning) *Phragmites australis* shoots and for areas that may have been accidentally missed on the first treatment. If P*. australis* was present, the average number of culms and height were noted per square meter. To determine degree of success of control efforts at each site, sites were placed into one of three categories:

1) <u>SUCCESSFUL</u> control efforts (sites that average less than 20 living culms per square meter and a majority of them less than 1m in height;

Figure 1: Successful eradication

2) <u>FAIRLY SUCCESSFUL</u> control efforts (average less than 50 culms per square meter and a majority of them less than 2m in height); and

Figure 2: Fairly Successful eradication

3) <u>UNSUCCESSFUL</u> control efforts (average more than 50 culms per square meter and a majority of them greater than 2m in height).

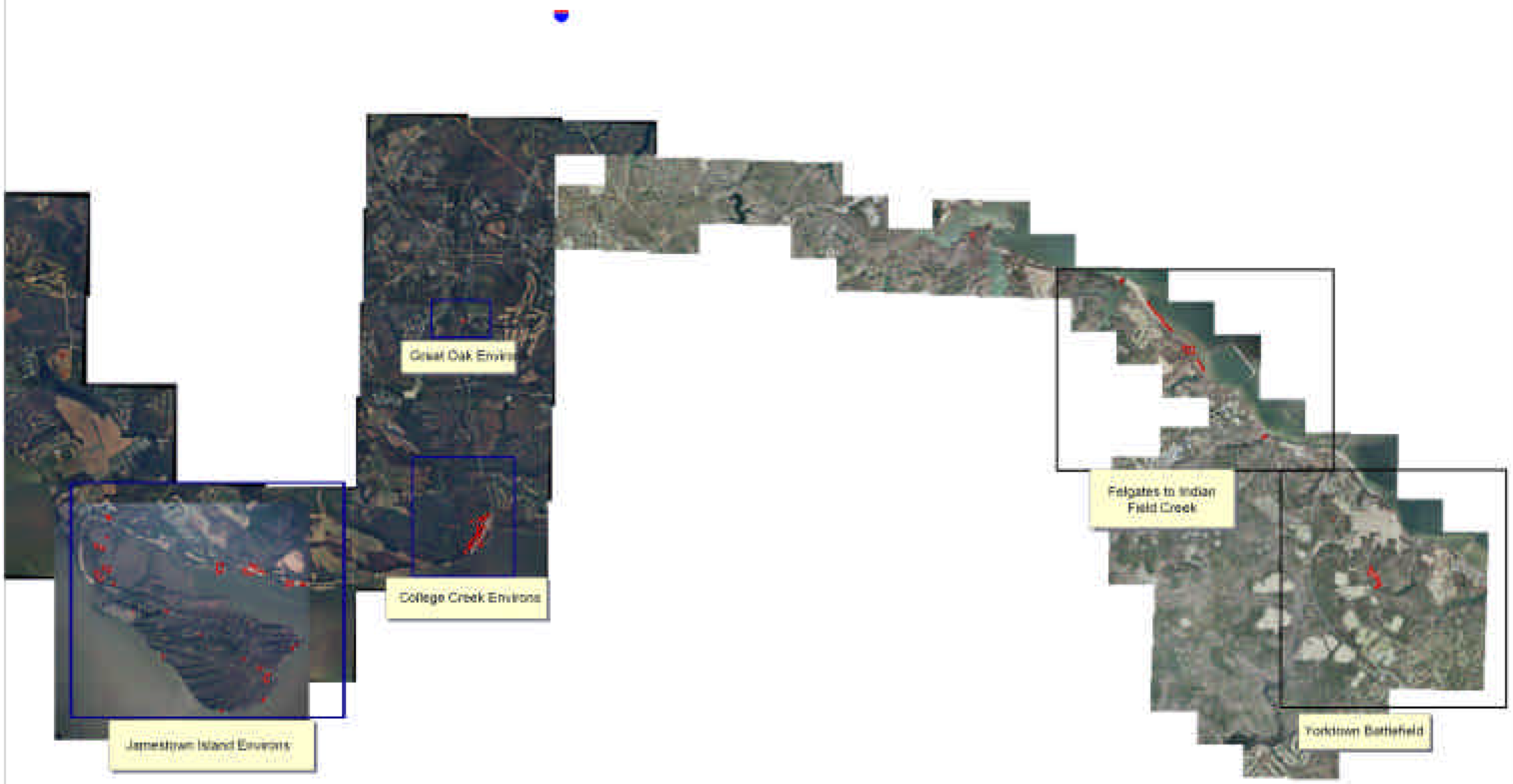
Figure 3: Unsuccessful eradication

Results and Management Recommendations

Of the 26 sites, 22 were visited and photographed, one (site 23) was not accessible, and three (site 19, 22, and 25) could not be located. In most cases, particularly along tidal waters, large, dense, monotypic stands of *Phragmites australis* were still observed, indicating that the 2003 control efforts had not been entirely successful. The poor effects of the spray efforts, particularly along the coastal waterways, may be due to several large storm events. Two Northeasters and one class one hurricane, Isabel, struck the COLO sites within several weeks of glyphosate application. The heavy flooding and rains from each storm may have decreased the

Phragmites Sites - Colonial NHP

National Park Service
U.S. Department of the Interior



Credit: Colonial National Historical Park, NRM

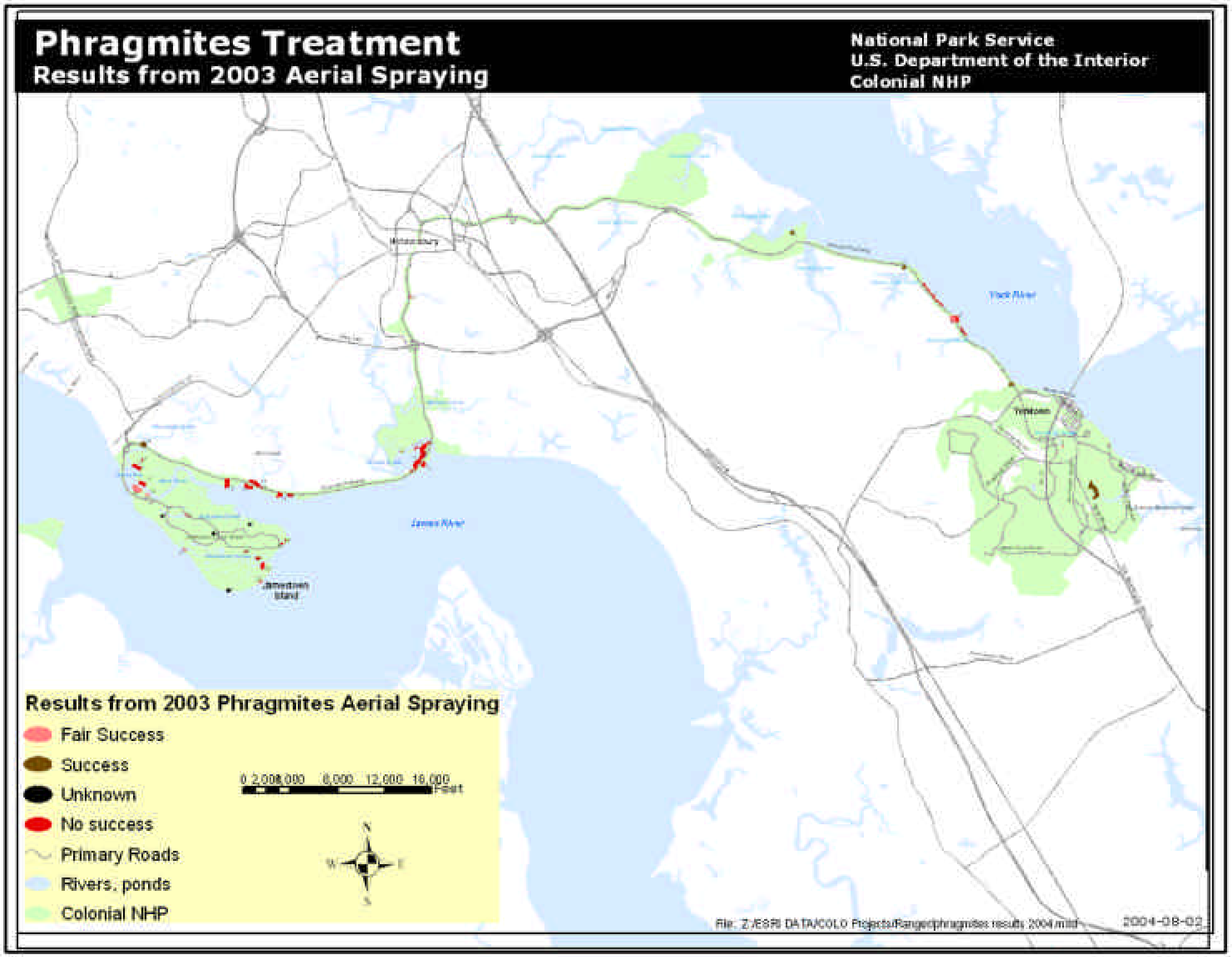
Date: 20040510

File: Phragmites plan VIMS.mxd

Phragmites

0 3,400 6,800 13,600 20,400 27,200 Feet

N


Phragmites Treatment
Results from 2003 Aerial Spraying
National Park Service
U.S. Department of the Interior
Colonial NHP
York River
James River
Yorktown
Jamestown Island
Results from 2003 Phragmites Aerial Spraying
Fair Success
Success
Unknown
No success
Primary Roads
Rivers, ponds
Colonial NHP
0 2,000 4,000 8,000 12,000 16,000
Feet
N
W
E
S
2004-08-02

spray effectiveness by causing premature senescence or dilution of the glyphosate.

A synopsis of control efforts is given below. Current observations, field notes, and recommendations for further treatments are given in Table 1. Figures for each site visited are presented at the end of the report.

SUCCESSFUL CONTROL

Sites: 1, 3, 8, 9, 16

FAIRLY SUCCESSFUL CONTROL

Sites: 2, 6, 10, 18, 20

UNSUCCESSFUL CONTROL

Sites: 4, 5, 7, 11, 12, 13, 14, 15, 17, 21, 24, 26

Table 1. HS=hand spray, AS=aerial spray.

VIMS Site #	Identification number(s)	approx. size (acre)	2004 observations and field notes	Year two recommended control methods
1	yt6.Phraus.a.1	6.03	Non-tidal. Successful eradication. Re-treatment may eradicate.	HS
2	yt11.Phraus.b.1	0.06	Non-tidal. Fairly successful eradication. However, spread to other portion of wetland noted	HS
3	cp2.Ligsin.b.2, cp2.cyndac.b.1	300 m2	Tidal. Successful eradication.	HS
4	cp4.Phraus.a.1, cp4.Phraus.b.7, cp4.Phraus.b.6	1	Tidal. Unsuccessful eradication, further treatment needed.	AS
5	cp5.Phraus.c.2, cp5.Phraus.c.1, cp4.Phraus.b.2, cp4.Phraus.c.2, cp4.Phraus.b.1,	2.31	Tidal. Unsuccessful eradication, further treatment needed.	AS
6	cp5.Phraus.c.3, cp5.Phraus.c.4, cp5.Phraus.b.3, cp4.Phraus.b.5, cp4.Phraus.b.4, cp4.Phraus.b.3,	>3 to 5	Tidal. Fairly successful eradication. An active military stand is less than 50 meters from site with mature *P. australis*.	HS
7	cp5.Phraus.b.1, cp5.Phraus.b.2.	?	Large site with mature *P. australis*. Unsuccessful eradication, further treatment needed.	AS
8	cp6.Phraus.b.1, cp7.Phraus.b.1	0.72	High marsh. Tidal. Successful eradication. Headwater area reveals mature stands of *P. australis*.	HS
9	cp9.Phraus.b.2	0.5	Tidal. Successful eradication. Waterward area reveals mature stands of *P. australis* and is spreading across the creek. Evaluate if the area across the creek needs treatment.	HS
10	cp22.Micvim.c.1	0.02	Non-tidal. Fairly successful eradication. Re-treatment may eradicate completely.	HS

11	cp26.Phraus.b.1 to b.27, cp26.Phraus.c.1 to c.2, cp27.Phraus.c.1 to c.5.,	~20	Tidal. Very, very large and extensive patches of *P. australis* located on both sides of road. Unsuccessful eradication, further treatment needed.	AS
12	cp30.Phraus.c.5 to c.7, cp30.Phraus.b.2 to b.4.	1.28	Tidal. Unsuccessful eradication, further treatment needed.	AS
13	cp30.Phraus.c.1 to c.4, cp30.Phraus.b.1,	2.73	Tidal. Cypress trees in marsh. Unsuccessful eradication, further treatment needed.	AS
14	cp.31.Phraus.b.1 to b.19	12	Tidal. Very large *P. australis* area. Unsuccessful eradication, further treatment needed.	AS
15	cp32.Phraus.c.1, cp32.Phraus.b.1, cp32.Phraus.b.2,	4.83	Tidal. Unsuccessful eradication, further treatment needed.	AS
16	cp34.Phraus.c.1 (no PhrAus)		Successful eradication.	HS
17	jt2.Phraus.a.3, jt2.Phraus.b.1, cp34.Phraus.b.1 jt2.Phraus.x.1 (jt2.Phraus.a.1, jt2.Phraus.a.2, jt2.Phraus.a.5)	< 5	Tidal. Unsuccessful eradication, further treatment needed.	AS
18	Jt2.Phraus.a.4, jt2.Phraus.c.1	0.34	Tidal. Fairly successful.	HS/AS
19	jt3.pautom.a.3	0.02	Not found	~
20	jt3.Phraus.a.1	0.5	Tidal. Eradication along the roadside successful-mature *P. australis* visible near the water edge.	HS
21	jt3.Phraus.a.2	0.15	Unsuccessful eradication, further treatment needed.	AS
22	jt3.Phraus.b.1	0.1	Not found possibly due to complete eradication	AS
23	jt4.Phraus.a.3	0.2	Tidal. Inaccessible, not visited	~
24	jt4.Phraus.b.1, jt4.Phraus.a.1, jt4.Phraus.b.2, jt4.Phraus.a.2	0.5	Unsuccessful eradication, further treatment needed.	AS
25	jt1.Phraus.b.3.	0.25 - 0.5	Not Found	AS
26	jt1.Phraus.b.1, jt1.Phraus.b.2	1	Tidal. Unsuccessful eradication, further treatment needed.	AS

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Appendix Summary of Methods for Controlling *Phragmites australis*

Following is a list of methods that have been used in controlling *P. australis* (modified from Norris et al. 2001). While not all are pertinent to the COLO area, they have been included for completeness.

I. Chemical Control

Spraying

Chemical spraying is one of the most popular choices of habitat managers. Translocation of the chemical to the root system can successfully kill the entire plant. The challenge lies in correctly timing the spraying application. Chemical spraying is most effective if applied in the fall, when a majority of the plants are in full bloom and leaves are fully open. During this time, the plant is actively moving stored energy from leaves to the complex rhizome system. Taking advantage of this energy shift insures the highest opportunity that the selected chemical will reach the rhizomes. In addition, in temperate zones, more desirable species such *Spartina alterniflora* and *Spartina cynosuroides* may have already begun to senesce reducing the potential for impacts to non-targeted species.

Glyphosate (N-(phosphonomethyl) glycine), sold under the trade name Rodeo 7 or Rodeo Pro 7 by Monsanto, is the most common herbicide used to control *P. australis*. It should be noted, however, that using a high concentration of chemical designed to translocate in the rhizomes (such as glyphosate), can result in top kill of the plant before the herbicide can be translocated properly, thus decreasing the effectiveness of the treatment. It is noted that split applications of glyphosate (at 1/2 dosages) can work better that a single, full strength application. The second dosage should be applied 15-30 days after the first (Cross and Fleming 1989).

The dense nature of *P. australis* may prevent complete chemical coverage and result in uneven stages of growth. So, repeat treatments may be necessary to maintain control (Brooker 1976). Seasonal burning, used in combination with spraying the vegetation, has been shown effective in reducing the above ground biomass thus increasing the opportunity for complete coverage when spraying (Cross and Fleming 1989).

Spraying comes in two forms: aerial and hand. Aerial spraying is done by fixed wing plane or helicopter and has been used successfully in large wetland areas greater than 10 acres. However, aerial spraying is not species selective and native species, such as *Spartina* and *Typha* are also affected. For smaller areas (<10acres) or areas with sensitive habitat and/or biota, hand spraying is recommended (see also “Wicking” and “Removal by Hand” below for alternative small area removal methods).

Wicking

Wipe-on herbicide application, or wicking, has been investigated as a more environmentally acceptable alternative to spray applications. The method utilizes canvas-covered, Speidel 7 applicators attached to a boom on each side of the boat or low ground pressure application equipment. The chemical saturates the canvas strips and is only applied to the plants that come in direct contact with the fabric. Chemical application through wicking allows for the targeting of *P. australis* without affecting the other, often shorter, plant species present in the treatment area. This method can be useful in areas where complete eradication of all vegetation is not desired.

However, care should be taken when using wicking equipment. The equipment can bend and break the plant, reducing the opportunity the chemical will reach the rhizomes and thus reducing the effectiveness of the treatment (Kay 1995). In addition to breaking plant stalks during application, the application boom also may cause much of the taller stalks to bend over and cover the shorter *P. australis* plants. This can effectively shield the shorter plants from the chemical, therefore reducing the rate of contact with the desired vegetation. In heavy weed stands, a double application in opposite directions may improve the results (Monsanto 1995). Yet, double applications will increase the treatment cost, effort and likelihood of stem breakage.

Sulfide Treatments

Studies have shown that sulfides react with salinity to greatly impact *P. australis* communities. Many of the die-back symptoms associated with field sites, namely stunted adventitious roots and laterals, bud death, callus blockages of the gas-pathways, and vascular blockages, were particularly acute at higher concentrations of acetic acid and sulfides (Armstrong et al. 1996). It has also been shown that an increase in sulfide in the rhizosphere reduces the ability of *P. australis* to take up nutrients relative to species such as *Spartina alterniflora* that are better-adapted to sulfuric soil conditions, thus restricting the distribution of *P. australis* in tidal saltmarshes (Chambers 1998). Sulfide treatments are not a viable option for COLO.

II. Mechanical Control

Water Management

Regulating the water level within the treatment area can be used to controlling *P. australis*. *Phragmites australis* roots require little oxygen and have well-developed mechanisms of flood tolerance. Therefore, flooding an established colony of *P. australis* may not be effective (Gries et al. 1990). However, if a water level greater than 30 cm is maintained, colonies will not expand and further increasing water levels can easily kills seedlings.

Tidal flushing can be effective in preventing *P. australis* from becoming established. But, a coastal location is required and increasing the salinity is more likely to hurt competing plants and the freshwater biota than control *P. australis* to the desired levels (Cross and Fleming 1989). Due to the dense nature of root and rhizome systems, wave action has been shown to have no effect on established stands of *P. australis*. In fact, the presence of *P. australis* actually reduced the amount of erosion normally caused by repeated wave action.

Water management is not a viable option for COLO.

Disking

Disking is more effective than plowing because the chopped rhizome pieces that result are often too small to be viable. The most effective time for cutting rhizomes is late in the growing season. In dry areas, the rhizome fragments may remain above ground to dry out or freeze. Disking in the summer or fall has shown a reduction in stem density during the next growing season. But, disking in late winter to mid-summer has actually stimulated bud production and resulted in *P. australis* stands with greater stem density (Cross and Fleming 1989). Disking is not a viable option for COLO.

Bulldozing

Bulldozing can be destructive to *P. australis* under certain conditions. Removal of vegetation can expose rhizome fragments to killing frosts, or fragments can dry out in non-flooded areas. However, this level of disturbance can also provide ideal growing conditions for *P.*

australis (Cross and Fleming 1989).

Dredging

Complete removal of *P. australis* through dredging can be difficult and destructive to the surrounding area. Rhizomes can reach depths of 2 m or more (Haslam 1970). Horizontal rhizomes must be removed and the area must remain deeply flooded (more than 1.5 m) following dredging or regrowth will almost certainly occur (Cross and Fleming 1989). Dredging is not a viable option for COLO.

Seasonal Mowing

Mowing a stand of *P. australis* has been shown to reduce biomass and increase the available sunlight to competing plant species within the stand. Spring mowing has produced shorter, but denser, *P. australis* stands within the same growing season. Yet, mowing for three consecutive summers in Canada resulted in a reduction of *P. australis* and a replacement of a short grass-sedge-sowthistle meadow (Cross and Fleming 1989). Mowing is not a viable option for COLO.

Cutting

Reducing the above ground biomass through labor-intensive cutting has produced mixed results. In one study, fall cutting did not increase species richness (Thompson and Shay 1989). Yet, hand-cutting 30-40 cm below the water level in June resulted in total eradication of the *P. australis* stand (Kay 1995). The level of the cut must be made below water level and a high water level maintained, to allow the shoot bases to become flooded with water from the top. This has been shown to result in the plant rotting beneath the water, especially when the cut is applied twice during one growing season (Husak 1978).

Short-term results were also obtained by cutting the vegetation at the onset of flowering. However, within two years, no significant differences were detected in the above ground biomass between treatment and control plots (Husak 1978). Cutting is not a viable option for COLO.

Plastic Barriers

Applying large plastic sheets to a treatment area can be an effective, non-herbicide option for eradicating *P. australis*. The site should first be mowed or burned to reduce the height of above ground biomass. Large sheets of 6-mm plastic can then be applied and held in place with stakes, sandbags or chains. As the under plastic temperatures increase, complete surface kill can be achieved in only 3-4 days. An increased application time could eventually kill the rhizomes as their energy storage is depleted and soil temperatures remain high (Boone et al. 1988). Using a clear plastic has been shown effective and it is suggested that using a black plastic could further increase under plastic temperatures.

However, large plastic sheets can be difficult to manage and hold in place, particularly in tidal marshes. Extended time in the sun can also increase the possibility of the plastic to deteriorate into hundreds of tiny pieces, making clean up difficult. Small animals located in the wetland area may be drawn to the warm temperatures located under the plastic sheeting and can potentially tear the material. The sharp tips of *P. australis* rhizomes have also been known to easily penetrate plastic sheeting. Plastic Barriers are not a viable option for COLO.

Perimeter Ditching

During construction of a new tidal wetland site, ditching around the perimeter may be effective in preventing the spread of rhizomes (Havens et al. 1997). While designing a new tidal wetland site, special attention should be given to elevation. In polyhaline areas much of the potential for *P. australis* invasion can be eliminated by concentrating restoration efforts to below mean high water (Priest 1989). The project should also include additional steps to eliminate areas available for *P. australis* development. These steps include planting a high density of vegetation, using mature scrub/shrub species and plantings along the upland berm. Perimeter ditching is not a viable option for COLO.

Burning

Habitat managers have traditionally used controlled burning as a quick and efficient method for removing above ground biomass and increasing soil nutrients. In fact, it is commonly used in combination with other *P. australis* control methods such as chemical spraying. However, new discussions are taking place concerning annual burns to control *P. australis* on wetland properties. Most professionals agree that removing the above ground biomass does indeed allow more sunlight to reach the soil surface and thus increases the opportunity for more desirable plants to sprout and grow. However, it is suggested that removing the above ground biomass on an annual basis may not allow the build up of nutrients to be returned to the wetland soil. In addition, the bare soil following a burn often provides prime disturbed conditions for the establishment of *P. australis*.

Shading

Seedlings of *P. australis* are susceptible to shading (Haslam 1971, Kudo and Ito 1988, Ostendorp 1989). Shading by shrubs and trees can reduce the density, height, and the proportion of flowering shoots, and can increase the number of dead tips (Lambert 1946, Kassas 1952, Haslam 1971). In created or restored areas, simply allowing scrub/shrub vegetation to mature can reduce *P. australis* to a minor component of the vegetative community (Havens et al. 2001). Shading is not a viable option for COLO.

Removal by Hand

Perhaps the most laborious method, but the least environmentally damaging, is to physically pull the *P. australis* plant from the ground. This method works well for very small populations but may not be practical for areas with an invasion that covers areas of greater than 0.25 acres. Care must be taken to assure that all root and rhizome material are removed with the plant.

III. Biological Control

Classical biological weed control is the introduction of host specific natural enemies (usually insects, less often pathogens) from the native range of the plant. Over 100 insect species are known to attack *P. australis* in Europe and about 50% of these are *P. australis* specialists. This provides ample opportunity to assess their potential as biological control agents (Blossey 2000).

The most promising potential biological control agents are rhizome and shoot mining moths and flies. The highest priority for investigation lies in the rhizome feeding insects, and is followed by the stem and leaf feeders. If an insect is discovered to destroy the rhizomes, the entire *P. australis* plant will be killed. When the desired control level is met, a controlled burn of the area destroys the insects along with the above ground biomass. Some of the insect species being investigated have recently been introduced to North America and the destructive potential of these species on *P. australis* is very promising (Blossey 2000). Biological control is not a viable option for COLO.